COMPOSITE BRIDGE EXPANSION JOINT

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FIELD OF THE INVENTION

The present invention relates generally to joints and, more specifically, to expansion joints.

BACKGROUND OF THE INVENTION

Due to weight and size of major components, concrete and steel road bridges are built on-site instead of pre-fabricated off site. On-site construction is expensive and time consuming. This results in traffic delays and safety concerns. Concrete and steel bridges also corrode and deteriorate over time. This requires continuous maintenance and upkeep, as well as costly inspection and repair.

On the other hand, bridges made of composite material, such as carbon/epoxy or fiberglass do not corrode. Advantageously, composite materials have high fatigue resistance, and high strength and stiffness-to-weight ratios. These characteristics of composite materials result in light-weight components. As a result, composite material components of bridges may be pre-fabricated off-site and easily transported to the site for final assembly.

The bridge components have coefficients of thermal expansion associated with the composite material from which they are made. The composite deck sections expand and contract according to their coefficients of thermal expansions and variations in temperature to which they are subjected. As a result, an expansion region is provided to accommodate thermal expansion or contraction.

It is required that such an expansion joint is provided between adjacent composite bridge deck sections. To avoid vertical steps in the surface, expansion joint components are made of the same material as the composite bridge deck sections so the expansion joint and the composite bridge deck section have the same coefficient of thermal expansion. However, there is an unmet need in the art for the expansion joint components to be made from the same composite material as the composite bridge deck sections, and for easy fabrication and assembly.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide an expansion joint for joining adjacent sections of a structure. In one presently preferred embodiment, the structure is a bridge, in which the adjacent deck sections are of composite construction. Advantageously, the expansion joint is preferably made from the same material as the adjacent sections. As a result, the present invention provides an expansion joint that has the same coefficient of thermal expansion as the adjacent sections of the structure and avoids steps in the surface. In composite embodiments of the present invention, the expansion joint is light weight, has high strength characteristics, and is easy to fabricate.

According to an embodiment of the present invention, an expansion joint is provided for joining adjacent sections of a structure. The expansion joint includes a first generally planar member that is configured to provide sliding support of at least one section of a structure thereon. Second and third generally planar regions are firmly attached to an expanding intermediate section that can slide on the lower main support beam. The second

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and third members are substantially co-planar with each other and are substantially parallel to the first member. The second and third members are vertically spaced-apart from the first member. The lower region of the intermediate member expands or contracts with temperature changes to allow it to be firmly attached to the adjacent panel members. The intermediate member is firmly attached to the main support structure at the center.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred and alternative embodiments of the present invention are described in detail below with reference to the following drawings.

FIGURE 1 is a perspective view of an expansion joint according to one embodiment of the present invention joining adjacent sections of a structure;

FIGURE 2 is a side view of an expansion joint of the present invention;

FIGURES 3A and 3B are partial cutaway, perspective views of a bridge with expansion joints according to the present invention;

FIGURE 4 is a top plan view of bridge deck sections joined by an expansion joint of the present invention; and

FIGURE 5 is a side view of an expansion join according to an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

By way of overview and referring to FIGURE 1, an embodiment of the present invention provides an expansion joint 10 for joining adjacent sections 12 and 14 of a structure 16, such as without limitation a bridge. The expansion joint 10 and the sections 12 and 14 are supported on a beam 17. Beam 17 is not necessarily of composite material. The expansion joint 10 includes a first generally planar member 18 that is configured to slide on a first portion 20 of the section 12 and a first portion 22 of the section 14 thereon. Second and third generally planar members 24 and 26 are configured to slidably receive a second portion 28 of the section 12 and a second portion 30 of the section 14 thereon. The second and third

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members 24 and 26 are substantially co-planar with each other and are substantially parallel to the first member 18. The second and third members 24 and 26 are vertically spaced-apart from the first member 18 by fourth and fifth members 25 and 27, respectively. An expansion device 32 is interposed between the second and third members 24 and 26. The device 32 is attached at its center to the beam 17 and is attached to the panels 12 and 14 away from the beam 17 to allow expansion. The gap 34 is maintained between the sections 12 and 14 to accommodate thermal expansion and contraction.

Referring now to FIGURES 1 and 2, features of one presently preferred embodiment of the expansion joint 10 will be set forth in further detail. The sections 12 and 14 are panel sections of the structure 16. Given by way of nonlimiting example, the sections 12 and 14 are load carrying bridge deck sections. The sections 12 and 14 have upper surfaces 36 and 38. The upper surfaces 36 and 38 each provide a surface suitable for surface traffic. For example, the surfaces 36 and 38 may be included among the surfaces of a bridge deck upon which vehicles or pedestrians travel.

The sections 12 and 14 are suitably made of composite material, such as without limitation carbon/epoxy or fiberglass. In this case, the expansion joint 10 is also made of similar composite material as the sections 12 and 14. Advantageously, this permits the expansion joint 10 and the sections 12 and 14 to have the same coefficient of thermal expansion. Alternately, the sections 12 and 14 may be made of other suitable materials, such as without limitation other materials having the same effective expansion characteristics, as desired for a particular application. The expansion joint 10 in this case is also made of the same material as the panel, such that the expansion joint 10 and the sections 12 and 14 have the same coefficient of thermal expansion. The spring material of component 32 need not be of the same material as the panels 12 and and 14. Regardless of the materials chosen for the expansion joint 10 and the sections 12 and 14, when the expansion joint 10 and the sections

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12 and 14 are made of the same materials the expansion joint 10 and the sections 12 and 14 have the same coefficient of thermal expansion.

The expansion joint 10 advantageously permits the sections 12 and 14 to abut each other with an expansion gap on the first member 18 instead of overlap each other on the expansion joint 10. This enhances symmetry and enhances ease of assembly and individual removal from the structure 16. To that end, lower faces 40 and 42 of the upper surfaces 36 and 38, respectively, are allowed to slide on top of the first member 18. Advantageously, in this embodiment, both of the sections 12 and 14 abut each other across a gap where the lower faces 40 and 42 are supported on the first member 18 and define the expansion gap 34. As such, the sections 12 and 14 advantageously do not overlap each other. Instead, the sections 12 and 14 present a smooth traveling surface. Further, when load from a vehicle or traveler (not shown) is presented across the expansion gap 34, advantageously the load is presented onto the expansion joint 10 at the first member 18 and is evenly distributed by the expansion joint 10 to the beam 17.

The expansion gap 34 is defined between ends of the sections 12 and 14 at the first portions 20 and 22, respectively. The expansion gap 34 may have a width that accommodates thermal expansion and contraction of the sections 12 and 14. The expansion gap 34 may be selected as desired for a particular application.

The sections 12 and 14 have lower faces 44 and 46, respectively. The lower faces 44 28 and 30 are received on the second and third members 24 and 26 at recesses 48 and 50 that are defined in the second portions 28 and 30 of the sections 12 and 14, respectively. At portions of the sections 12 and 14 other than the second portions 28 and 30, the lower faces 44 and 46 are received upon the beam 17.

Holes 52 and 54 are used to connect sections 28 and 30 of the sections 12 and 14, respectively to sections 24 and 26 of connector 18 and line up axially with the holes 52 and 54. Suitable fasteners (not shown), such as bolts, are received within the axially lined-up

holes 52 and 56 and the axially lined-up holes 54 and 58. This fastens the sections 12 and 14 to the expansion joint 10. However, sections 12 and 14 remain unfastened to the beam 17.

In one presently preferred embodiment, the connecting device 32 is an expansion spring. The expansion spring has elasticity to allow the required expansion with sufficiently low stress levels to avoid fatigue failure. The spring is suitably corrugated for this purpose. The corrugated member 60 suitably defines peaks 62 and 64 and a trough 66 interposed between the peaks 62 and 64. A hole 68 is defined in the trough 66, and a hole 70 is defined in the beam 17. The holes 68 and 70 are axially aligned with each other. A suitable fastener, such as a bolt 72, is received within the axially-aligned holes 68 and 70 and is secured with a nut 74 or the like. This secures the expansion joint 10 to the beam 17.

In summary, the sections 12 and 14 are fastened at the second portions 28 and 30, respectively, to the expansion joint 10 at the second and third members 24 and 26. However, the sections 12 and 14 are not fastened to the beam 17. Instead, the expansion joint 10 is fastened to the beam 17. The first portions 20 and 22 of the sections 12 and 14 are slidably received on the first member 18 and define the expansion gap 34 therebetween. As the sections 12 and 14 thermally expand or contract, the first portions 20 and 22 slide along the first member 18. To this end, the expansion gap 34 advantageously accommodates thermal expansion of the sections 12 and 14. Further, as the sections 12 and 14 thermally expand or contract, the expansion or contraction causes the second and third members 24 and 26 (that are attached to the sections 12 and 14 via fasteners through the second portions 28 and 30) to move toward each other or move away from each other. However, the device 32 allows movement of the second and third members 24 and 26. As a result, the expansion gap 34 varies with temperature. Because the expansion member 18 and the sections 12 and 14 have the same expansion characteristics, sections 12 and 14 remain in horizontal alignment. The expansion or contraction is substantially the same for the expansion member 18 and the sections 12 and 14.

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Referring now to FIGURES 3A, 3B, and 4, a bridge 16 advantageously is constructed using several of the expansion joints 10. A plurality of the beams 17 are supported on a plurality of supports 76. The expansion joints 10 are placed on top of the beams 17 perpendicular to the beams 17 and are fastened to the beams 17 with the fasteners 72 as described above. The sections 12 and 14 are fastened to the second and third members 24 and 26 with fasteners through the holes 52 and 54 as described above.

FIGURE 5 shows an expansion joint 110 according to an alternate embodiment of the present invention. It will be appreciated that like reference numerals are used to refer to components or items previously described with reference to the expansion joint 10 (FIGURES 1-4). The expansion joint 110 is configured to join overlapping sections 112 and 114 of a structure 116. The structure 116 is similar to the structure 16 (FIGURES 1-4). The sections 112 and 114 panel sections, such as panel bridge deck sections, and are suitably constructed similar to the sections 12 and 14. An upper surface 136 of the section 112 abuts an upper section 138 of the section 114 across a gap at first portions 120 and 122, respectively to define the expansion gap 34. An overlapping portion 121 of the section 112 extends beyond the upper surface 136 and is able to slide on the first member 18. The bottom of the first portion 122 slides on top of the overlapping portion 121. As a result, load is distributed by the sections 112, 114, and the expansion joint 110 when weight transitions between the sections 112 and 114.

The first, second, third, fourth, and fifth members 18, 24, 25, 26, and 27 are constructed as set forth for the expansion joint 10. However, an expansion device 132 suitably includes an expansion member 160 that performs the same function as the expansion device 32. The member 160 advantageously has a simple shape that is easy to fabricate.

The second and third members 24 and 26 define the holes 56 and 58 that axially line up with the holes 52 and 54 that are defined in the sections 112 and 114. A hole 180 is defined in the beam 17 and is axially aligned with the holes 52 and 56. A suitable fastener

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(not shown) fastens the section 112 and the expansion joint 110 to the beam 17 via the holes 52, 56, and 180. Another suitable fastener (not shown) fastens the section 114 to the expansion joint 110 via the holes 54 and 58, but not to the beam 17.

While the preferred embodiment of the invention has been illustrated and described, as noted above, many changes can be made without departing from the spirit and scope of the invention. Accordingly, the scope of the invention is not limited by the disclosure of the preferred embodiment.

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